B737NG Alerting Issues – Single engine failure/fire

1. Initiating Condition: Engine failure after V1 and prior to V2

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other Issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Visual Alerts	"ENG FAIL" on respective EGT indicator (forward panel upper display unit) or PFD as installed	N2 rpm less than 50%				ENG FAIL alert is removed when the failed engine recovers or has been secured
	Low Oil Pressure light on forward panel (may precede the ENG FAIL alert, be simultaneous with it, or be seconds after it depending on cause of engine failure)	Loss of oil pressure			Blinking of amber alert boxes is inhibited during takeoff from 80 knots to 400 RA. Alert still illuminates amber, though	
	Master caution light	Driven by hydraulic and/or source off annunciations				
	Low oil pressure pointer turns amber/red and enters amber/red band (PFD/ND installations, on lower DU, others on upper DU)	Loss of oil pressure				
	Hydraulic annunciator with master caution (usually alerts seconds after ENG FAIL as adequate hydraulic pressure is maintained for a while by a wind milling engine)	Loss of engine driven pump output pressure due to reduced N2 rpm				Alert terminated when/if fire switch is pulled (disarms engine driven hydraulic pump low pressure indication)
	SOURCE OFF light and IDG DRIVE light on overhead panel with ELEC annunciator light with Master Caution (presented after but may be almost simultaneous with ENG FAIL alert)	Engine driven generator (IDG) drops off line due to reduced N2 rpm				SOURCE OFF alert terminated when respective bus is covered by APU
Aural Alerts	None					

B737NG Alerting Issues – Single engine failure/fire

1. Initiating Condition: Engine failure after V1 and prior to V2 – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other Issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
Tactile Alerts	None					
Visual Cues	Abnormal EGT, N1, N2, oil temperature, and/or oil pressure gauge indications					
	Nose yawing off runway centerline					
Aural Cues	Sounds of engine malfunction may occur		These sounds may be similar to those from engine surge and tire failure			
Tactile/ Somatic Cues	Lateral g					
	Rudder pressure required to stay on runway					
	Reduced longitudinal acceleration					

Expected Pilot Response(s)

- Control the aircraft.
- Execute single engine takeoff/climb profile.
- Identify and execute appropriate non-normal checklist.

Possible sources of confusion with regard to pilot response(s)

- Stress, time pressure, startle.
- Confusion among engine surge, engine failure, tire blowout.
- Partial engine failure may present difficult diagnosis and decision as to whether to shut down.

Issues with regard to multiple concurrent non-normal conditions

- Engine failure presents concurrent electrical, hydraulic, and/or fuel system alerts, cues that may require additional action.
- Uncontained engine failure may present additional multiple alerts and failures.

B737NG Alerting Issues – Single engine failure/fire

2. Initiating Condition: Engine failure in cruise flight with autopilot engaged

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other Issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
Visual Alerts	"ENG FAIL" on respective EGT indicator (forward panel upper display unit)	N2 rpm less than 50%				ENG FAIL alert is removed when the failed engine has been secured
	Low Oil Pressure light on forward panel, amber and also three associated boxes blink for first 10 seconds (may precede the ENG FAIL alert, be simultaneous with it, or be seconds after it depending on cause of engine failure)	Loss of oil pressure				
	Low oil pressure pointer turns amber/red and enters amber/red band (PFD/ND installations, on lower DU, others on upper DU)	Loss of oil pressure				
	Hydraulic annunciator with Hyd master caution (usually alerts seconds after ENG FAIL as adequate hydraulic pressure is maintained for a while by a wind milling engine)	Loss of engine driven pump output pressure due to reduced N2 rpm	Alerts from secondary system failures (hydraulic, electrical) may confuse pilots about the nature of the event; e.g., they may be distracted by these cues and not realize the engine has failed			Alert terminated when/if fire switch is pulled (disarms engine driven hydraulic pump low pressure indication)

B737NG Alerting Issues – Single engine failure/fire

2. Initiating Condition: Engine failure in cruise flight with autopilot engaged – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other Issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
Visual Alerts	SOURCE OFF light and IDG DRIVE light on overhead panel with ELEC annunciator light (presented after but may be almost simultaneous with ENG FAIL alert)	Engine driven generator (IDG) drops off line due to reduced N2 rpm	Alerts from secondary system failures (hydraulic, electrical) may confuse pilots about the nature of the event; e.g., they may be distracted by these cues and not realize the engine has failed			Source Off alert terminated when respective bus is covered by APU
Aural Alerts	None					
Tactile Alerts	None					
Visual Cues	Abnormal EGT, N1, N2, oil temperature, and/or oil pressure gauge indications					
Aural Cues	Sounds of engine malfunction may occur		These sounds may be similar to those from engine surge and tire failure			
Tactile/ Somatic Cues	Wheel may move opposite the roll if autopilot is engaged					Control wheel displacement cues are reduced/eliminated after trimming the rudder

Expected Pilot Response(s)

- Control the aircraft.
- Identify and execute appropriate non-normal checklist.
- Perform single engine approach and landing.

Possible sources of confusion with regard to pilot response(s)

- Stress, time pressure, startle.
- Partial engine failure may present difficult diagnosis and decision as to whether to shut down.

B737NG Alerting Issues – Single engine failure/fire

2. Initiating Condition: Engine failure in cruise flight with autopilot engaged – Cont.

Issues with regard to multiple concurrent non-normal conditions

- Engine failure presents concurrent electrical, hydraulic, and/or fuel system alerts, cues that may require additional action.
- Uncontained engine failure may present additional multiple alerts and failures.

B737NG Alerting Issues – Single engine failure/fire

3. Initiating Condition: Engine fire after V1 and prior to V2

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other Issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Visual Alerts	Master fire warning light (red, forward panel)	Temperature sensed by engine fire loop	Confusion between fire with and without engine failure			
	Master caution light (amber, forward panel)	Temperature sensed by engine fire loop				
	OVHT/DET annunciator light amber, forward panel)	Temperature sensed by engine fire loop				
	Fire switch light (red, center console)	Temperature sensed by engine fire loop				
	Engine overheat light (amber, center console)	Temperature sensed by engine fire loop				
Aural Alerts	Fire bell	Temperature sensed by engine fire loop				
Tactile Alerts	None unless engine also fails					
Visual Cues	None unless engine also fails					
Aural Cues	None					
Tactile/ Somatic Cues	None unless engine also fails					

B737NG Alerting Issues – Single engine failure/fire

3. Initiating Condition: Engine fire after V1 and prior to V2 – Cont.

Expected Pilot Response(s)

- Control the aircraft.
- Execute V1 engine failure/fire flight profile.
- Execute engine fire procedure (begin procedure above 400 feet or immediately upon reaching single engine acceleration altitude, this is earlier than for engine failure procedure).
- Perform single engine approach/landing procedures.

Possible sources of confusion with regard to pilot response(s)

- False fire warning cannot readily be distinguished from valid fire warning (see condition 4 below).

How does pilot know condition is resolved/recovered?

- Fire warning indication that fire is extinguished.

Issues with regard to multiple concurrent non-normal conditions

- Engine fire will devolve to an engine failure, either as a direct result of and simultaneous with the fire onset or as part of the engine fire procedure.
- Engine fire presents concurrent electrical, hydraulic, and/or fuel system alerts, cues that may require additional action.
- Engine fire may present cascading emergency (e.g., hydraulic failures, smoke in cabin, etc.).
- Uncontrollable fire may present additional, cascading conditions (e.g., structural failure, fuel loss, need to expedite landing, or even land off-airport).

B737NG Alerting Issues – Single engine failure/fire

4. Initiating Condition: False fire warning from engine bleed leak, during takeoff after V1 and before V2

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other Issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Visual Alerts	Master fire warning light (red, forward panel)	Temperature sensed by engine fire loop	Warning is false, there is no fire. There are no salient cues to the fact that there is no fire; absence of engine failure is not, in itself, diagnostic of a false fire warning.	False fire warning can lead to unneeded RTO, engine shutdown, etc.	Burn through of fire detection can suppress valid warnings, leading to false indication that fire has been extinguished	Lower temperature sensed by engine fire loop
	Master caution light (amber, forward panel)	Temperature sensed by engine fire loop	Warning is false, there is no fire. There are no salient cues to the fact that there is no fire; absence of engine failure is not, in itself, diagnostic of a false fire warning.	False fire warning can lead to unneeded RTO, engine shutdown, etc.	Burn through of fire detection can suppress valid warnings, leading to false indication that fire has been extinguished	Lower temperature sensed by engine fire loop
	OVHT/DET annunciator light amber, forward panel)	Temperature sensed by engine fire loop	Warning is false, there is no fire. There are no salient cues to the fact that there is no fire; absence of engine failure is not, in itself, diagnostic of a false fire warning.	False fire warning can lead to unneeded RTO, engine shutdown, etc.	Burn through of fire detection can suppress valid warnings, leading to false indication that fire has been extinguished	Lower temperature sensed by engine fire loop
	Fire switch light (red, center console)	Temperature sensed by engine fire loop	Warning is false, there is no fire. There are no salient cues to the fact that there is no fire; absence of engine failure is not, in itself, diagnostic of a false fire warning.	False fire warning can lead to unneeded RTO, engine shutdown, etc.	Burn through of fire detection can suppress valid warnings, leading to false indication that fire has been extinguished	Lower temperature sensed by engine fire loop
	Engine overheat light (amber, center console)	Temperature sensed by engine fire loop	Warning is false, there is no fire. There are no salient cues to the fact that there is no fire; absence of engine failure is not, in itself, diagnostic of a false fire warning.	False fire warning can lead to unneeded RTO, engine shutdown, etc.	Burn through of fire detection can suppress valid warnings, leading to false indication that fire has been extinguished	Lower temperature sensed by engine fire loop

B737NG Alerting Issues – Single engine failure/fire

4. Initiating Condition: False fire warning from engine bleed leak, during takeoff after V1 and before V2 – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other Issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Aural Alerts	Fire bell	Temperature sensed by engine fire loop	Warning is false, there is no fire. There are no salient cues to the fact that there is no fire; absence of engine failure is not, in itself, diagnostic of a false fire warning.	False fire warning can lead to unneeded RTO, engine shutdown, etc.	Burn through of fire detection can suppress valid warnings, leading to false indication that fire has been extinguished	Bell canceled by the pilots as part of procedure
Tactile Alerts	None					
Visual Cues	None					
Aural Cues	None					
Tactile/ Somatic Cues	None					

Expected Pilot Response(s)

- Control the aircraft.
- Execute V1 engine failure/fire flight profile.
- Execute engine fire procedure (begin procedure above 400 feet or immediately upon reaching single engine acceleration altitude, this is earlier than for engine failure procedure).
- Perform single engine approach/landing procedures.
- If fire cannot be extinguished, expedite landing.

Possible sources of confusion with regard to pilot response(s)

- False fire warning cannot readily be distinguished from valid fire warning.

Issues with regard to multiple concurrent non-normal conditions

- False indication of engine fire will likely devolve to an engine failure as part of the engine fire procedure.
- If false indication of fire continues after engine fire NNPs are performed, pilot concerns about inextinguishable fire may prompt risky alternative actions (e.g., rushing, off-airport landing, etc.).